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ANCIENT LAKES ON MARS?

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The valley systems in Mars' ancient cratered terrain provide strong evidence for a warmer and wetter climate very early in the planet's history. Examination of Viking orbiter images shows that the valley systems in some instances debouch into closed depressions that could have acted as local ponding basins for flow. Ancient craters, for example, can provide such a setting. A survey of Mars' equatorial region using USGS 1:2,000,000 photomosaics shows that numerous local depressions at the confluence of valley systems exist. These depressions are typically of the order of ~ 100 km in size, and are characterized by many valleys flowing into them and few or none flowing out. If flow ponding did take place, these basins would have contained lakes for some (perhaps brief) period during Mars' early warmer epoch.

Although the collection basins are numerous, location of ones that have not suffered significant subsequent geologic modification is difficult. When examined in detail, many basins are found to exhibit morphologic features (such as "wrinkle ridges") which suggest that volcanic lavas may have filled them subsequent to any early fluvial activity. Many Martian lavas had very low viscosities, and the lava, like the water, tended to flow into locally depressed regions. For this reason, the basins that exhibit possible volcanic features have not been given high priority in our mapping efforts. It is worth noting, however, that subsequent cratering would be very effective at punching through lava units and excavating whatever lies underneath.

Two detailed maps of valley systems and local ponding basins in USGS 1:2,000,000 sub-quadrangles have been completed and a third is in progress. The completed regions are in Mare Tyrrhenum (MC-22 SW) and Margarifer Sinus (MC-19 SE), and the region in progress is in Iapygia (MC-21 NW). On these maps (to be exhibited at the meeting), the valley systems and interpreted margins of ponding basins have been indicated. Some of these margins are the rims of ancient craters, while others have irregular shape and are simply local closed depressions among surrounding craters. The floors of the basins are generally very smooth as seen in Viking orbiter medium resolution images. In one case, however, the floor deposits have a complex hummocky topography which resembles features (such as patterned ground and pingoes) formed on Earth from multiple freeze-thaw of water-saturated sediments.

From a geological perspective, these depressions are of interest for two reasons. First, regardless of whether the water that drained into them formed long-lived lakes or ephemeral playas, the depressions were surely the sites in which the materials eroded from the valleys were deposited. The physical nature of such sediments could preserve important information about the physical conditions that existed in the basins at the time of deposition. Second, the chemical composition of the sediments could preserve evidence of water-atmosphere interactions during the early period of Martian climate. Atmospheric carbon dioxide would dissolve in the water, and would react with cations brought in by the inflowing streams. The cations would react with the hydrated carbon dioxide to form solid carbonate minerals (e.g., CaCO_3) that would tend to precipitate out of solution to form carbonate sedimentary deposits. Formation of carbonates in this manner might account for some of the CO_2 lost from the early more dense atmosphere.